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NEW HAMPSHIRE COLLEGE
Agricultural Experiment Station
IN COÖPERATION WITH THE
State Board of Agriculture

SECOND REPORT

The BROWN-TAIL MOTH
IN NEW HAMPSHIRE

THE WINTER WEB.
CUT AND BURN IT!

By E. DWIGHT SANDERSON
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NEW HAMPSHIRE COLLEGE
OF
AGRICULTURE AND THE MECHANIC ARTS
DURHAM

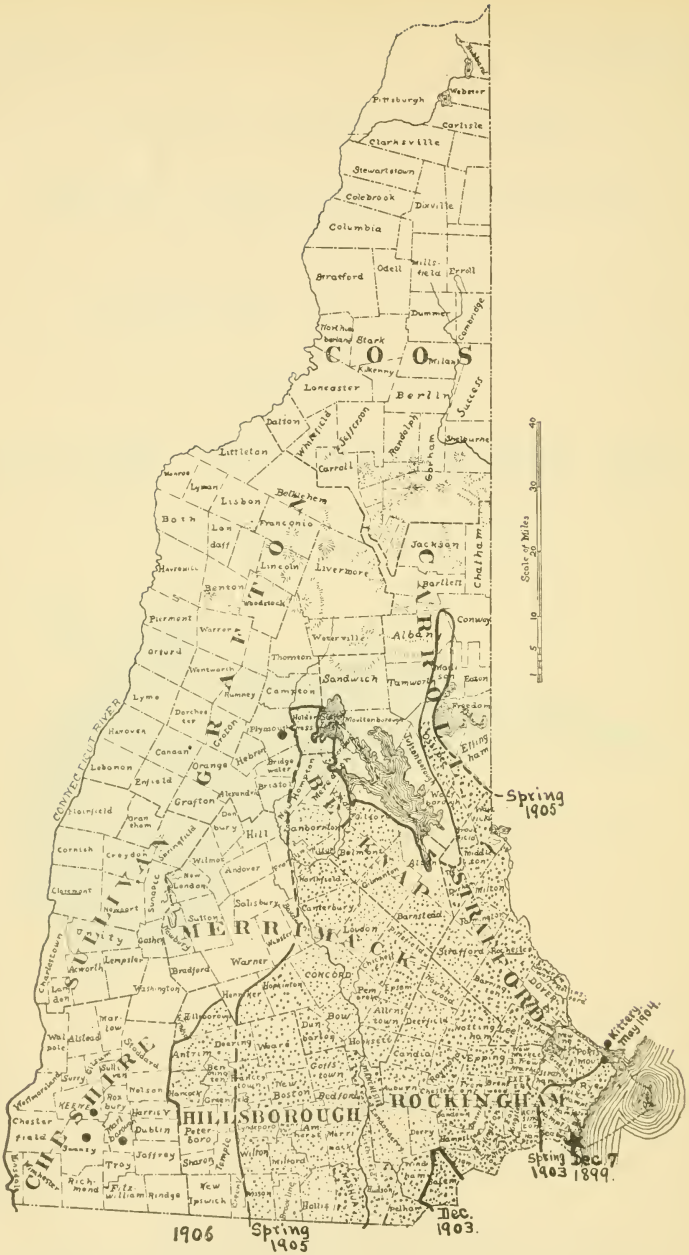


FIG. 1.—Map showing the gradual spread and distribution of the Brown-Tail Moth in New Hampshire. Dotted area infested in 1906. Heavy lines indicate outer boundaries of areas infested in years indicated at margin. Dash lines represent approximate boundaries not personally investigated, based on points infested north of these points. Black circles show points examined in January, 1906, and found uninfested.

THE BROWN-TAIL MOTH.[1]

HISTORY.

The brown-tail moth was probably introduced into this country at Somerville, Mass., on nursery stock imported from Europe about 1890. Not until 1897 did it attract the attention of the Massachusetts Gypsy Moth Commission, whose agents thoroughly investigated the pest. No funds were then available for controlling it, though the Legislature passed a law "requiring the local authorities to suppress the brown-tail moths," and the Massachusetts Board of Agriculture determined its spread. In 1898 the work of controlling this insect was placed in the hands of the Massachusetts State Board of Agriculture, with $10,000 of the funds appropriated for the gypsy moth available for such work. Since that time the control has been in the hands of the local authorities.

In Europe this is one of the oldest and best known of the caterpillar pests, being called the "common caterpillar." It has been known there since the times of the earliest writers upon insects and natural history, excellent accounts of it having been written nearly three centuries ago. It is common over Central and Southern Europe, Western Asia and Northern Africa, and extends north into Sweden.

SPREAD AND DISTRIBUTION.

Occurring over a dozen towns when first recognized in 1897 and there being at no time a well-organized effort having sufficient funds for its control, the pest spread rapidly and in December, 1899, the first of its winter nests was found in New Hampshire, at Seabrook. Its spread since that time is approximately shown on the map, figure 1. Portsmouth and the coast towns became infested in 1901 and 1902 and in the spring of 1903 they were found to comprise the in-

[1] *Euproctis chrysorrhœa* L.

fested area in New Hampshire, with the exception of the southern part of Stratham. In December, 1903, no nests were found in Atkinson, and but few in Salem, N. H., along the Massachusetts line, they becoming scarce and disappearing northward in Salem, thus showing that the pest had not spread much over the line west of the eastern part of Rockingham County. The greatest spread occurred in 1904 during the summer flight of the moths in July. On Saturday, July 9, the moths invaded Nashua in immense swarms, so that the electric light posts and wires were white with them and they were reported in large numbers on all the principal streets by the police. At Newmarket they appeared on July 12, "by the million," according to Mr. Pinkham of *The Advertiser*, who stated that two quarts of the dead moths were taken from one arc-light globe and the front of a church was covered as if by a snowfall. On July 22 but few moths were to be seen in Newmarket. Further north the moths do not seem to have appeared in such numbers, though Manchester, Concord and Rochester became well infested. The spread in 1904 was the greatest recorded, the northernmost infested points being North Conway and Holderness, representing a spread of some seventy-five miles in that season, undoubtedly occurring during the flight of the moths. The exact spread in the southwestern part of the state was not determined as definitely as was desired, but there seemed to be but little infestation west of Concord. Inspections made by assistants of this office showed that Contoocook and Henniker were slightly infested, but Warner and Hillsborough were not. Specimens were received from several towns south and slightly east of these.

In February, 1904, this station issued a warning bulletin on the brown-tail moth by Dr. C. M. Weed, so that the public was well informed concerning it. In January, 1905, in coöperation with the state board of agriculture, a poster was circulated throughout the infested portions of the state, considerable attention was given the matter by the press,

granges, schoolteachers and others, so that everyone was awake to the necessity of controlling the pest by removing the winter webs. As a result the webs were very generally destroyed throughout the southern part of the state, this being aided with appropriations by many of the towns. To this effective work is undoubtedly due the fact that there was not more spread in 1905. Examination made by my assistant, J. L. Randall, shows that the northernmost limits of infestation have not been extended, though rather more webs are found at Laconia and other towns in that latitude, while to the southwest only one row of towns further west were found to be infested as far as we have been able to determine from a hurried inspection, including Hancock, Bennington and Antrim. Keene and Marlborough seem to be uninfested. Reinfestation has undoubtedly taken place from the southern part of New Hampshire and Massachusetts by moths flying northward during the past summer, for in many places the infestation is more serious in January, 1906, than in January, 1905, though the nests were carefully removed very generally over the towns. This is noticeably so in Durham. This but emphasizes the necessity for requiring all towns to control the pest within their borders.

LIFE HISTORY.

The Winter Webs, or Nests.—During the winter the well-known webs of the brown-tail moth caterpillars are to be found on the tips of the twigs of fruit and shade trees. Typical examples are shown in figure 2.

These webs are usually about three or four inches long, composed of leaves woven together with silk, which forms a firm, tough web. The whole nest is often attached to the twig by the stems of the leaves, which have been worked into it, the stems being wound round and round with silk and this being continued onto the twig, as shown in the figure. If a nest be torn open it will be found to contain numerous little round, white, silky masses, looking like

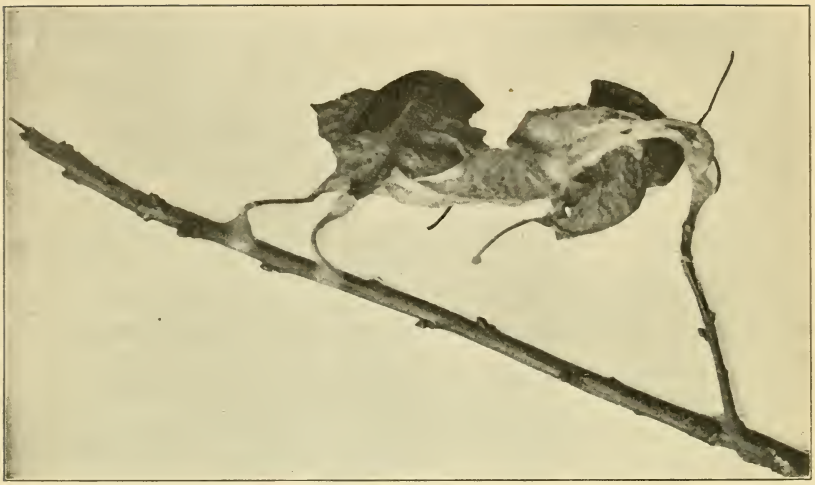


FIG. 2.—Winter web of the Brown-Tail Moth. (After Weed.)

spider's eggs, each of which contains two to a dozen small, brown, hairy caterpillars about one-sixth of an inch long (Fig. 3). At one side or lower end of the web is found

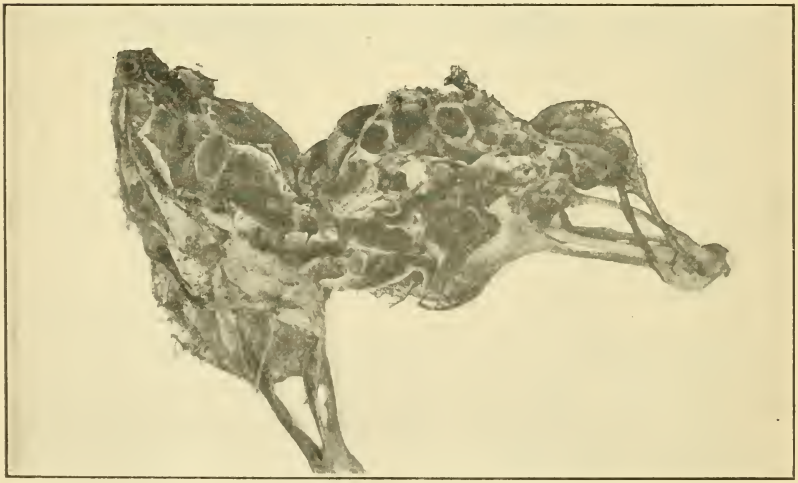


FIG. 3.—Winter web opened to show the different compartments or cells, each containing young caterpillars within.

a mass of black excreta and the cast skins of many of the small caterpillars, for during the warm days of fall the caterpillars feed more or less upon the dead leaves composing the web. and many of them molt in the web. Thus the leaves of the web often become pretty well skeletonized.

FIG. 4.—Old web of tent caterpillar.

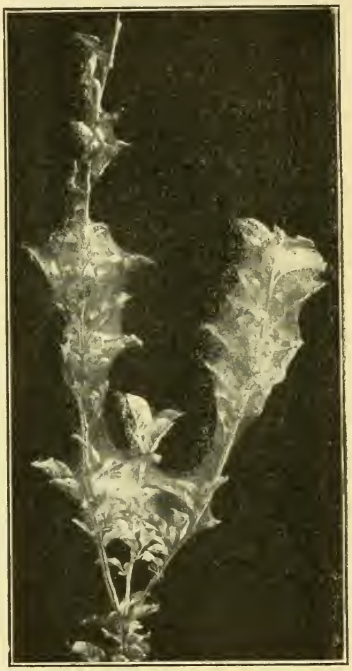


FIG. 5.—Web of fall web-worm covering foliage. (After Weed.)

There are no other webs common on trees which may be mistaken for these. Any webs containing small caterpillars in winter are those of the brown-tail moth. The tent-caterpillar and fall web-worm both make webs which often remain on the trees over winter, but they are weatherworn. thin webs, with no caterpillars, and are much larger. The curled elm leaves caused by the elm aphis often remain on the trees over winter and may prove misleading to one

FIG. 6.—Elm leaf curled by aphis. (From Weed.)

FIG. 7.—Eggs of Rusty Tussock Moth.

whose eye is not trained to detecting the brown-tail webs. The eggs of the rusty tussock moth frequently found on fruit trees, especially plum, are often brought in for the eggs of the brown-tail where bounties are paid for its webs, but as the brown-tail's eggs are laid only in summer there should be no confusion.

With the warm days of late April and early May the little caterpillars emerge from their winter's home, the balance of which they often devour before going to the opening buds, upon which they feed greedily. The first emergence noted in Massachusetts was on March 18, 1898, the 29th of April being given as about the last of their appearance. In 1905 the first caterpillars emerged at Durham on April 21 and continued to emerge until May 10, the largest number emerging on May 6, thus commencing to appear about the time the maximum temperature reached 60° Fahr. and the maximum emergence taking place about

the time the maximum reached 80° Fahr. A record of the caterpillars emerging from 10 nests of average size gave an average of 375 per nest, the largest number being 444 and the smallest 172. The webs vary greatly in size, however, as Fernald and Kirkland found as few as 47 and as many as 802 in a single web.

An examination of the caterpillars in five winter webs made during the winter of 1905 showed an average of about 25% dead. After the remarkable warm weather of January 21–23, 1906, a careful examination of nine nests was made, having an average of 220 caterpillars each, of which 10% were dead, the smaller mortality possibly being due to the mild winter up to that date.

FIG. 8.—Small Brown-Tail Moth caterpillars emerging from the winter web and feeding on the leaves of its surface.

It seems quite probable that were a few unusually warm days to occur in early spring, so as to cause the caterpillars to leave the webs, followed by a sharp freeze, that many of them might be killed, as were the forest tent caterpillars in 1900 (see Bulletin 81, *p.* 11). Considerable comment has arisen in the

FIG. 9. — Young Brown-Tail Moth caterpillars, just from nest; 4 times natural size.

daily press concerning the effect of the warm weather of January 21–23, 1906, upon the caterpillars, some stating that they had emerged from the webs. As far as we have been able to observe none of the caterpillars emerged at that time. The influence of the unusual temperature conditions is now being studied by us, by determining the mortality of the caterpillars in the webs at different periods during the winter. Had the warm weather been followed by a very sudden low temperature, the effect upon the caterpillars would more probably have been fatal. Various experiments upon this point were conducted last winter and are being continued, but are not at present conclusive.

When they first emerge from the winter nest the young caterpillars (Fig. 9) are of a blackish color covered with warm-brown or reddish-brown hairs. The head is jet black, while the body is marked with yellow when seen under a lens. Projecting from the back of the fourth and fifth segments is a large tuft of reddish-brown hairs, looking like a brush, and about two thirds the height

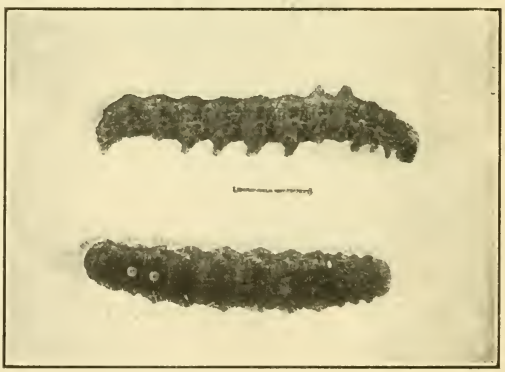


FIG. 10.—Second spring stage of the caterpillar, enlarged 4½ times; natural size shown by line.

of the body. On the middle line of both the ninth and tenth segments is an orange or coral-red retractile tubercle. These details may be seen in figure 9. In about eight days the caterpillars shed their skins or molt, after which

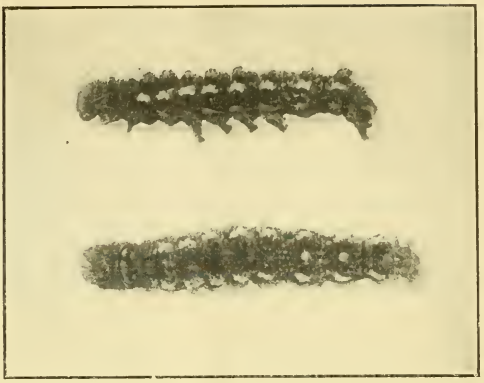


FIG. 11.—Full grown caterpillars of Brown-Tail Moth; enlarged 1½ times.

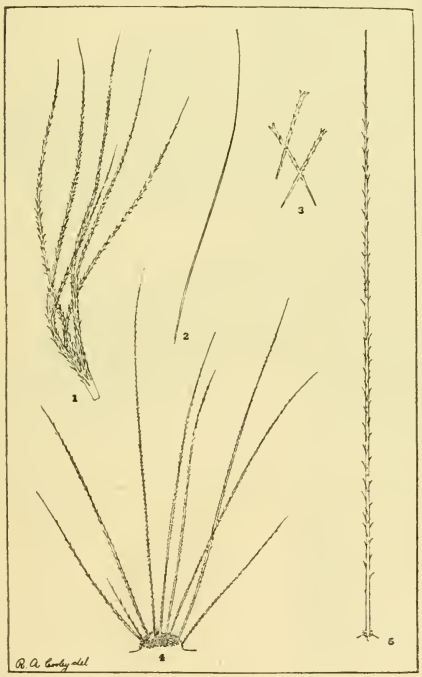


FIG. 12.—Various forms of hairs from Brown-Tail Moth caterpillar. (After Fernald and Kirkland.)

they are about two fifths of an inch long (Fig. 10), the body hairs are relatively longer, though the tufts on the fourth and fifth segments are not so large. About the middle of May (15th to 20th), the second spring molt occurs. The caterpillar is now about three fifths of an inch long, the yellow markings of the body being more apparent, and the brown tufts on the back less prominent. In this stage the upper hairs of the tubercles along the sides of the ab-

dominal segments are a distinct white color, forming a band of white dashes along either side of the caterpillar, which is so characteristic of it. The third molt occurs during the last week of May (May 28–30, 1905), this usually being the last molt before pupation, but sometimes, as described by Fernald and Kirkland, a fourth molt occurs, thus making five stages of the caterpillar in the spring. The caterpillars are now usually full grown (Fig. 11), and from an inch to an inch and a quarter long. The head is pale brown,

Fig. 13.—Several Brown-Tail Moth cocoons on leaves.

FIG. 14.—Pupæ, 1½ natural size. Male and female.

mottled with darker brown. The body is dark brown or black, well marked with patches of orange and covered with numerous tubercles bearing long barbed hairs. The tubercles along the back and sides of the abdomen are thickly covered with short brown hairs in addition to the longer ones, which give these tubercles a velvety appearance under a lens. It is these short hairs (Fig 12 at 3) which are the "nettling hairs." The white dashes along the sides of the abdomen are more prominent and enable the immediate identification of the caterpillar of the brown-tail moth from any other in New England. (See Fig. 11.)

Pupa.—During the second week in June the caterpillars spin up thin silken cocoons of white silk among the leaves, a number often spinning cocoons together, so as to form a considerable mass of web. The cocoon is so loose in structure that the cater-

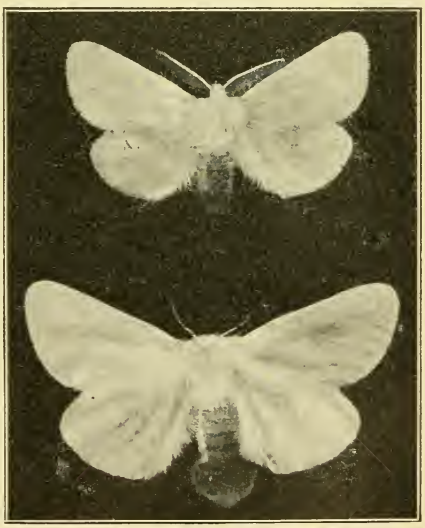


FIG. 15.—Brown-Tail Moths, natural size. Male above, female below.

pillar, or pupa, may be readily seen through it. Where abundant, they will make the cocoons (Fig. 12) under fences, beneath clapboards and in similar retreats. In these the caterpillars transform to pupæ about the middle or third week of June (June 15–18, 1905). The pupa, shown in figure 14, is slightly over half an inch long, of a dark brown color, with a conical spine armed with numerous small hooks at its tip. Smooth, yellowish-brown hairs are scattered over the abdomen and thorax, but none are on the antennæ, legs or wing-covers. The pupal stage lasts for about twenty days.

Fig. 16.—Eggs of the Brown-Tail Moth on leaf. (After Kirkland.) Reduced.

The Moth.—Most of the moths emerge during the second week of July (July 6 to 10, 1905, mostly emerging on 7th and 8th). They usually emerge late in the afternoon and are ready to fly that night. Both sexes are pure white, except the abdomen, which is dark brown. The wings of the males expand about one and one third and those of the females one and one half inches, as shown natural size in figure 15. The tip of the abdomen of the female forms a large tuft or brush of golden or dark brown hairs, to which is due the name of the insect. The moths are strong fliers and are readily attracted by lights.

Eggs.—Egg-laying commences at once. The eggs (Fig. 16) are usually deposited on the under sides of the outer leaves of the tree, toward the tips of the limbs. An egg mass is about two thirds of an inch long by one fourth of an inch wide, contains from two to four hundred eggs, and is covered with dark brown hair from the tip of the abdomen

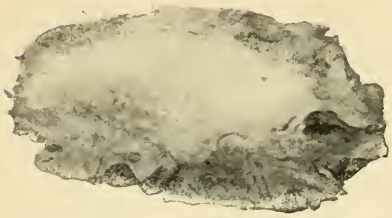
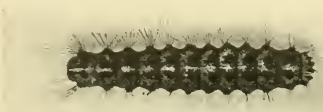
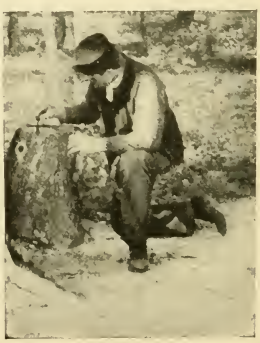
of the female. The egg mass is elongate and is decidedly convex or ridged.

The eggs hatch in about three weeks, about the first of August. (Those at laboratory hatched July 31 to August 4, 1905. Were observed hatching at Rochester August 10, when almost all had hatched.) The young caterpillars feed upon the surfaces of the leaves, skeletonizing them, and when abundant causing the foliage to turn brown, as if blighted or scorched by fire (Fig. 17). At first they feed upon the leaf which bears the egg mass, but soon wander to others, returning at night to the original leaf. The little caterpillars are but a twelfth of an inch long when they first emerge, but in about five days they molt for the first time, after which they are about one fifth of an inch long. A week or so later a second molt occurs, though often this is within the winter web during the fall. Early in September the young caterpillars instinctively commence to weave the nest or web, their winter home. It is made of the leaves upon which they have been feeding, usually including the old egg mass at the tip of the twig. The form and shape of the web varies with the position and the materials available. Exit holes are left open so that the caterpillars may go in and out as long as the weather is propitious, but are usually closed during the winter.

Compared with the Gypsy Moth.—Inasmuch as the brown-tail and gypsy moths both were imported into the same region in Massachusetts and have spread simultaneously, they are very commonly confused. "That they were both transported across the Atlantic to the same locality by totally dissimilar agencies," as remarked by Mr. Kirkland[1], "must stand as one of the remarkable entomological events of the century just closed." And, it might be added, furnish the strongest evidence of the need of more rigid legislation against and inspection of all importations, either foreign or interstate, which may harbor insect pests. In view of this common confusion, a comparison of the stages and lives of these two insects was prepared for a recent bulletin (121) on the gypsy moth, and is here reprinted:

[1] Report Massachusetts Horticultural Society, 1902.

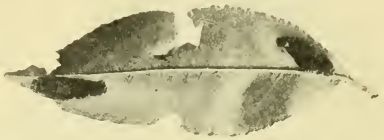
THE STAGES AND LIVES OF THE GYPSY MOTH

Stages.	Gypsy Moth.
Egg Cluster	Usually on bark of tree; very rarely on leaf. Robust, 1½ to 2 inches long. Light yellow or creamy. From August to May.
	
Caterpillar. Full grown	Dark grayish or sooty. Double row of five pairs of blue, followed by six pairs of red spots along back.
	
Moth. Female	Wings spread 2¼ in. Dingy-white, lightly streaked and blotched with blackish. No brush of brown hairs at tip of abdomen. Does not fly, crawls.
Winter Passed	In egg stage—see above. Never as a caterpillar.
Irritation of Human Skin	Not caused by any stage.
Most Effective Means of Control. Soak eggs with creosote in fall, winter, or spring.	

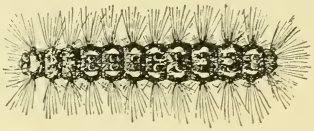
AND BROWN-TAIL MOTH CONTRASTED.

BROWN-TAIL MOTH. STAGES.

Always on under side of leaf.....EGG CLUSTER.
Smaller and more slender.
Dark or golden brown.
July.

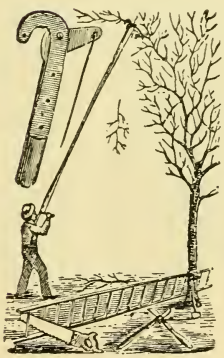


Bright tawny or orange.....CATERPILLAR.
A conspicuous row of pure white spots or dashes along each side of body. Only two bright red spots on middle line at lower end of back.



Wings spread 1½ inches.....MOTH, Female.
Pure snow white.
A conspicuous, sharply contrasted, thick tuft or patch of golden or brownish hairs at tip of abdomen.
A swift, strong flyer by night, and attracted to lights.

As small caterpillars in a silken web or nest on tips of twigs, from which they crawl out in spring.....WINTER PASSED.



IRRITATION.

Hairs from caterpillars, which are often transferred to cocoons and moths, cause an annoying and painful irritation of the skin.

MOST EFFECTIVE MEANS OF CONTROL.

Cut off and burn webs in winter.

Fig. 17.—Leaves eaten by young caterpillars which have just emerged from egg mass at left, showing characteristic injury in fall.

MEANS OF DISTRIBUTION.

The principal spread takes place through the flight of the moths just after emergence. "These insects fly freely and have a habit of soaring upward above the tree tops and buildings. When the moths in their nocturnal flights have thus risen in the air, they are often drifted by the wind over long distances." (Fernald and Kirkland.) Thus the strong winds of mid-July, 1897, are known to have carried the moths far northward from the point of origin in Massachusetts and similar winds were undoubtedly responsible for the unusual spread northward and eastward in 1904.

It should be noted in this connection that as the moths are strongly attracted by lights they usually swarm around the electric lights in the center of a town and are always found first in towns and cities, which become centers from which the surrounding country becomes infested. This is a fortunate feature of their spread, for being thus naturally concentrated it is much easier to control the pest on the few town trees than if scattered over the country.

Due to this attraction by lights, the moths have often been spread by electric and railway cars, and possibly steamers, but particularly electrics, the moths flying into the cars and being carried some distance. It has been noticeable in a newly infested territory that the infestation runs along the electric car lines in advance of the main spread. Like those of the gypsy moth, the young caterpillars have the habit of dropping down from the trees by spinning a strand of silk by which they are suspended, so that they may be picked up by any passing vehicle or may crawl upon it and thus be carried. Undoubtedly this often occurs, but as the spread takes place so much more rapidly by the flight of the moths, it is of minor importance.

FOOD PLANTS AND INJURY.

The pear is the preferred food plant of the caterpillars and is usually first infested where available; the apple

comes next and, owing to its abundance, is the tree upon which the webs are first most commonly found in a newly infested section. All of the fruit trees and of the shade trees, elm, oak and maple, are freely attacked, in fact, almost all fruit, shade and forest trees, except the pines, spruces and other conifers are attacked in a badly infested district. Injury to woodlands and forests does not seem to be as serious as that inflicted by the gypsy moth, though often the defoliation is sufficient to cause large tracts to appear brown and seared. As yet, woodlands have not been infested sufficiently for a time long enough to definitely determine just how serious the constant total or partial defoliation by the brown-tail caterpillars will be. It is well known, however, that any deciduous tree wholly defoliated for three or four years is usually killed, and that the wood growth is seriously checked by partial defoliation, so that there is a distinct loss in the timber value.

As the pest concentrates in towns, the shade and fruit trees suffer most and, unless the winter webs are removed, being defoliated year after year, become weakened and soon die. As when defoliated by cankerworms, tent-caterpillars or other caterpillars, fruit trees stripped of their foliage can hardly yield a crop of fruit and the control of the pest upon them is therefore imperative.

DANGER TO HEALTH.[1]

One of the most serious effects of the presence of the brown-tail moth in a community is that of the peculiar skin disease it may produce. Some of the hairs of the full-grown caterpillars are furnished with minute barbs. When the caterpillars molt these barbed hairs are shed with the skin and as the skins become dry and are blown about by the wind the hairs may be quite generally disseminated. When the hairs alight upon the human skin they cause an irritation, which upon rubbing may develop into inflammation. In New Hampshire this phase of the insect's pres-

[1] Largely reprinted from Bulletin 107 by C. M. Weed.

ence has already become evident. At Portsmouth a clothes-reel was near a tree infested by the caterpillars. The family were greatly troubled through the summer by extraordinary irritations of the skin, for which they were unable to account, but which were doubtless due to caterpillar hairs blown from the pear tree to the clothes upon the reel. In the same city a gentleman, in removing a caterpillar which had landed upon his neck, scattered some of the hairs, which produced an eruption similar to but considerably worse than that produced by poison ivy.

In Massachusetts, where the infestation has been longer known, this danger has become very generally recognized. The following experiences recorded in the report on the brown-tail moth, by Messrs. Fernald and Kirkland, are simply examples of many others which have been reported to the authorities:

A lady in Somerville wrote: "We were shockingly poisoned by the caterpillars of the brown-tail moth. They troubled us all summer. Every member of my family was poisoned. At first we did not know what they were. My little boy could not go near the insects without getting poisoned,—every time he went to pick cherries he would come down from the tree badly poisoned. If my baby went near where they were, his face would break out into a rash. I was so dreadfully poisoned that I thought I had some frightful disease. My hands, face and arms were broken out with this rash. Most of the caterpillars came from a neighbor's place. They came over the fence into the house and even into the closets. They would get on the clothes hung on the line, and when these were worn they poisoned us."

A Somerville physician wrote: "The first we saw of these moths was in 1897. The first cases of poisoning I saw were on Spring Hill Road and Park Street. I saw a number of cases and they were all about the same, except that they varied in point of severity. Some of the cases were very obstinate, and did not respond well to treatment. The same symptoms developed in nearly all cases. The trouble began

with an intense irritation, then an eruption appeared, resembling eczema, with a sort of watery blister on the top. There was intense irritation all over the body, on the head, arms and limbs. I saw numbers and numbers of cases of this poisoning; I should say nearly a hundred cases in all came under my observation. The irritation seemed to remain and was much worse than that caused by poison oak or poison ivy, and was not so easily gotten rid of. I treated most cases with some cooling application. Some cases were decidedly obstinate, but no case was serious enough to menace the life of the patient."

Investigations by Massachusetts authorities of this consequence of the presence of the brown-tail moth showed that it was due to the mechanical irritation of the barbs of certain short hairs on the body of the caterpillar; these hairs are called the nettling-hairs. "These nettling-hairs are very small, only about one two hundred and fiftieth of an inch in length, very sharp at one end, and with two or three barbs at the other end and many along the sides. These barbs are so arranged that when these nettling-hairs fall upon the skin any movement will cause them to work into the flesh. The nettling of the skin may be caused by contact with the caterpillars in either of the last two molts, the cocoons, and to some extent with the moths, but contact is not necessary, as these fine nettling spines may fall or be blown by the wind."

The true nettling hairs are the short brown hairs giving the tubercles of the back and sides of the abdomen a brown velvety appearance, shown in figure 12 at 3, and do not appear until the last two stages of the caterpillar's growth. Nettling may be produced, however, as we have learned from experience, by the younger stages, even those in the webs, where they are freely handled by one with a tender skin. No inconvenience would occur to anyone, however, from handling the unopened webs, and rarely will the young caterpillars be annoying.

FIG. 18.—Pimpla fly on cocoon of tent caterpillar. One of the native parasites of the Brown-Tail Moth. Twice natural size. (After Weed.)

FIG. 19.—A predaceous bug (*Brachymena 4-pustulata*), such as feed upon the Brown-Tail caterpillars, seen from below, and showing the long, sharp beak between the legs, upon which the caterpillars are impaled.

NATURAL ENEMIES.

A number of parasitic insects which commonly live upon our native caterpillars attack the larvæ and have been bred from the pupæ (Fig. 18) of the brown-tail moth. Predaceous bugs (Fig. 19) also appear in numbers on infested trees and devour large numbers. Toads and bats eat the moths as they fly to electric lights. The worst enemy of the moths, however, is the English sparrow, which attacks them eagerly and consumes large numbers, as well as killing many not eaten. All of the common birds which feed upon our native hairy caterpillars feed upon those of the brown-tail, particularly the Baltimore oriole, cuckoos and yellow-throated vireo. When the moths commence to emerge they join with the sparrows in the slaughter and between them large numbers are destroyed. But as yet the native enemies have not shown ability to materially check the increase of the pest.

It is well known that in Europe the insect seems to be largely controlled by its natural enemies, so that serious outbreaks occur but once in a number of years in any one locality, in the same manner as do outbreaks of our native

insects, such as the forest tent caterpillar or white-marked tussock moth, which are controlled by native parasites. A determined effort is, therefore, now being made by the Massachusetts superintendent, in coöperation with the Bureau of Entomology of the United States Department of Agriculture, in importing those parasites and predaceous insects which prey upon the brown-tail and gypsy moths in Europe. Already large numbers have been imported from all parts of Europe and are being carefully reared in strict confinement at Saugus, Mass. It is the hope of everyone that these importations may result, within a few years, in such an increase of these enemies that they will be able to control these pests. It is the belief of the writer that ultimately either imported or native enemies will control them, as they do our native insects; but Nature works slowly, and whether such a condition will arise in five, ten or one hundred years, it is impossible to predict, as we have no experience with imported pests of a nature sufficiently similar to furnish us any precedent for comparison. Obviously, therefore, it will be folly to place any dependence upon these natural enemies until their value and ability to even partially control the brown-tail moth is clearly established.

REMEDIES.

Destruction of the Winter Webs.—Of all the means for controlling the brown-tail moth, the destruction of the winter webs or nests is by far the most important, the most practical, economical and efficient. The webs are conspicuous on the tips of the limbs from October to April and usually may be readily removed by pole shears or long-handled pruners. All webs should be collected and burned in a stove, as they do not burn readily and if burned in an open fire out of doors some may be merely scorched, and if the nests be allowed to lie on the ground or in a brush heap the young caterpillars will emerge in spring and usually find plenty of food. When the snow is on the ground the nests may be more readily found where they drop. On large trees with numerous nests it is well to have one man below the tree to point out the nests to two or three men doing the pruning, thus saving time and ensuring thorough work. Long ladders and climbing irons will occasionally be necessary for high trees and will be found

useful by those making a business of collecting the webs. All webs should be removed by April 1.

The question is often asked, "Will it pay me to clean the webs from my own trees if my neighbor does not?" A glance at figure 20 will answer this better than argument. From the habits of the pest it is apparent that but little spread takes place except by the winged moths in late sum-

FIG. 20.—Pear tree defoliated by the caterpillars of the Brown-Tail Moth. The webs on the trees in the background were destroyed the previous winter. Photograph taken at Vine Street, Somerville, Mass., May 27, 1897. (After Fernald and Kirkland.)

mer. If the caterpillars are so abundant as to spread from neighboring property they may be prevented by sticky bands on the uninfested trees as described below.

Spraying.—While the caterpillars are young they may be effectively destroyed by spraying with arsenate of lead. The brown-tail caterpillars seem to be much more susceptible to the poison than those of the gypsy moth. Experiments made by us during the past season in the laboratory indicate that if sprayed while the caterpillars are young early in May that arsenate of lead at the rate of three pounds per barrel of water should be sufficient, but if delayed until late in May or June 1, when they are nearly full grown, five pounds per barrel should be used. More

elaborate field experiments concerning the strength necessary will be conducted this year.

After the eggs have hatched in August the trees may also often be sprayed to advantage so as to prevent the work of the young caterpillars and the consequent checking of the fall growth of the tree, except in the case of trees in fruit.

Spraying or sprinkling with kerosene emulsion or strong soap solution will often destroy the caterpillars when they swarm on fences and walks.

Banding.—Uninfested trees may often be protected by applying a band of some sticky substance over which the caterpillars are unable to cross. This will *not* be effective (1) if the branches of the trees interlock with those of an infested tree; (2) if the trees stand so close together that the small caterpillars can pass from one to the other while suspended on their fine threads; (3) if the band either hardens or becomes covered with dust so that it does not remain sticky; and (4) if the caterpillars are allowed to become so numerous beneath the band that they form a bridge over it with their threads and dead bodies. The bands should therefore be frequently inspected and the caterpillars below them removed or destroyed. If not destroyed they will often leave the trees for shrubbery, where it is more difficult to cope with them, and will transform to moths. "Insect lime, raupenleim, tanglefoot, bodlime, printer's ink, or even axle grease are among the materials most used for banding. All may be dangerous to the tree and should be removed after the caterpillar season has passed." (Kirkland.) Possibly the most satisfactory and safest substance is printer's ink applied as a band on heavy building paper, beneath which is placed a band of cotton next to the bark of the tree to prevent the ink from injuring the tree and the ascent of the caterpillars in the crevices of the bark beneath the paper.

This banding will not, however, prevent reinfestation by the winged moths, which fly to them and deposit their egg clusters in July, so that it is not as efficient as in the case of the gypsy moth, which does not spread by flight, and which makes apparent the necessity of destroying the insect in its immature stages as far as possible, so that the winged moths may not spread, if its numbers are to be reduced from year to year.

Destroying Pupæ.—Late in June and early July the cocoons containing the pupæ may be gathered, though it is likely to be attended with severe inflammation of the skin

from the nettling hairs if precautions are not taken. Such cocoons or pupæ should be placed in a barrel or box covered with mosquito screening so that the moths are confined but any parasites which develop may escape through the screen.

Destroying the Moths.—Often the electric light and telegraph poles near lights are covered with the white-winged moths, in which case they may be largely destroyed by washing down with a stiff jet of water from the hydrant hose. A spray of pure kerosene or kerosene emulsion may also be found desirable under some circumstances for destroying the moths.

NECESSITY OF THE CONTROL OF THE BROWN-TAIL MOTH.

In the southeastern corner of the state, where the brown-tail moth has now become abundant, everyone is impressed with the importance of doing everything possible to suppress or control it, as are those persons who have been unfortunate enough to have visited in the infested district in Massachusetts during the caterpillar season. In general the New Hampshire public seems alive to the necessity of the control of the pest. As a result the last Legislature enacted a law (Senate bill 22) authorizing "the several towns and cities of the state" "to appropriate and expend money to limit and if possible exterminate the ravages of the brown-tail moth and other insect pests." In 1905 most of the towns of southeastern New Hampshire appropriated money for the control of the pest. Some placed the funds in charge of the tree warden while other offered a bounty for each winter nest collected. The bounty method is fairly effective where the nests are few and has the value of arousing general public interest and coöperation in the work. Where the nests become more numerous, better results may be more economically secured by the town or city appropriating funds to some official who may hire reliable men, who will soon become expert at the work, and will see that all trees are thoroughly cleaned. All trees along the public highways and in parks should be cleaned by them, and their services should be placed at the disposal of property owners who would pay the actual wages of those employed by them, as far as would not interfere with the town work. At the present time the authority which the town or city has over trees along the public highways seems to be more or less poorly defined and in connection with the work against the brown-tail and gypsy moths it is of the utmost importance

that legislation be enacted which will, if possible, clearly define the rights and duties of the towns and municipalities in this regard.

Attorney-General Eastman has kindly informed the State Board of Agriculture that "the highways agents and the selectmen of towns, one or both, may remove the webs of the brown-tail moth from trees within the limits of the public highways." He further states that neither selectmen nor city councils probably have power to enact ordinances compelling property owners to remove the webs. This being the case, it is highly desirable that state legislation be enacted, which might well be patterned after the Massachusetts law in this respect, requiring all property owners to remove the webs and requiring town officials to see that this is properly done, appropriating a sufficient sum, so that after a reasonable amount has been expended by property owners and towns the state will stand a share of the expense of such work. Otherwise one town may carefully remove the webs each year and yet will make no headway against the pest, owing to the neglect of a neighboring town.

Appropriations for this work have been made by many towns in town meeting only sufficient for the work of that spring. It were much better if a sufficient sum were voted to cover the work of that spring and the following winter, stating that only so much could be used prior to November of that year. This would make work possible during the good weather of early winter.

IDENTIFICATION OF SPECIMENS.

The writer will be glad to identify any specimens thought to be brown-tail moth webs or caterpillars. He will also be materially assisted in determining the spread and abundance of the pest if (1) all information possible be sent him concerning its occurrence outside of the area indicated on the map, figure 1, and (2) if local officials having charge of removing webs will keep account of the number of webs removed from street trees and forward the record to him each year, as in this way a comparison of the abundance in different parts of the state may be made.

For further accounts of the brown-tail moth see,—Fernald and Kirkland, "The Brown-Tail Moth," Massachusetts State Board of Agriculture, pages 73, plates 14, 1903, and Kirkland, Bulletin 1, Office of Superintendent for Suppression of Gypsy and Brown-Tail Moths, 1905.

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